APPARATUS FOR FLUSHING, REPLACING FLUID AND BLEEDING HYDRAULIC SYSTEMS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to the servicing of hydraulic systems and more particularly to an apparatus for flushing contaminants from hydraulic systems by recirculating the used fluid and subsequently replacing it with new fluid and bleeding air from the system.

2. Description of the Prior Art

Hydraulic fluid is used to transmit the pressure exerted on a motor vehicle's brake pedal to the slave cylinders provided at the wheels of the vehicle. The most commonly used hydraulic brake fluids consist of glycol-based liquids identified as DOT3 and DOT4 on the basis of the boiling points resulting from their particular composition.

Copending U.S. Ser. No. 10/030,455, hereby incorporated by reference, discloses a novel approach for estimating the condition of brake fluid based on the discovery that moisture content is closely correlated to the copper content in the fluid. The invention consists of a reactive test strip adapted to measure and indicate the concentration of copper ions in brake fluid in terms of a readily visible color change. The strip is immersed in the fluid and the resulting color acquired by reacting with the fluid is compared to a copper concentration-versus-color chart or to a standard color representative of the maximum concentration determined empirically to correspond to a fluid condition considered appropriate for normal operation.

Another important aspect of brake system maintenance is the corrosive nature of some of their constituents, which, upon contamination of the brake fluid, progressively contribute to damage of the metallic tubing and other parts of the brake system. In conventional brake fluids, amines are added to inhibit corrosion and prevent damage to metal parts that operate in contact with the fluid. As the brake fluid ages, its anticorrosive properties are measured in terms of reserve alkalinity; that is, the amount of amines remaining in the fluid to buffer the acidity resulting from a breakdown of the fluid constituents. Over time, thermal oxidation and volatization produce a significant reduction of the amine content and the concurrent decrease in anticorrosive properties. Tests have shown that the reserve alkalinity of DOT3 and DOT4 fluids is reduced to about 20 percent of its original value after 18 to 20 months of normal operation. Therefore, brake fluids need to be checked and periodically replaced in order to prevent the development of potentially unsafe conditions in the brake system. Accordingly, industry maintenance recommendations are typically based on service time and milage of the vehicle.

Following the work described in U.S. Ser. No. 10/030,455, it has been found that copper content is predictably related also to time and milage of vehicle operation. Thus, this correlation has similarly been used to determine the need to replace the fluid based on "virtual age"; that is, the wear and tear on the brake fluid, rather than the actual service time and/or milage. If a color change in the test strip indicates a higher-than-desirable copper concentration, the brake fluid is considered in need of replacement without further tests. This invention is described in copending U.S. Ser. No. 10/132,978.

The prior art methods for replacing deteriorated and contaminated brake fluid with new fluid are varied, however, the most common method used is a two-person operation which takes about 45 minutes to an hour to complete. Usually, the master cylinder is drained of the old fluid, cleaned and then refilled with new clear fluid. Then one person attaches a drain line to the bleeder valve of one of the wheel cylinders and opens the bleeder valve and the other person pumps the brake pedal to move the new fluid through the system to expel the old fluid out through the bleeder valve and through the drain line into a suitable container. When the clear new brake fluid emerges from the open bleeder valve, draining of the old fluid from that branch of the system is terminated and the valve is closed. This operation is repeated for each wheel cylinder with new brake fluid being added to the master cylinder as needed during the draining operation. When the brake system is drained and refilled in this manner, it must subsequently be bled to remove the air introduced during the draining and refilling operation. This prior art method of replacing old brake fluid with new fluid has several drawbacks; it is time consuming, requires the services of two people, and uses an excessive amount of brake fluid in that the new fluid which emerges from the bleeder valves during the replacement and bleeding operations cannot be reused due to it having been exposed to system contamination.

Some of these drawbacks have been overcome by a closed system fluid replacement apparatus and method disclosed in U.S. Pat. Nos. 6,206,055 and 6,302,167 to Peter C. Hollub. The Hollub apparatus includes a vacuum wand which extracts the old fluid and contaminants from the master cylinder. A fill pump is used for supplying new fluid under pressure from a closed container to the master cylinder and at the same time a vacuum pump is connected to extract the old fluid from all of the bleeder valves simultaneously and directing it to a closed waste fluid tank. Also disclosed is the periodic shutting off and restarting of the fill and vacuum pumps to produce a fluid surging to flush contaminants from the system. The Hollub apparatus does away with the need for using two-man and reduces the time required to complete the replacement operation. However, the Hollub apparatus is not especially efficient in flushing the old brake fluid and contaminants from the brake system. When the old brake fluid is extracted from all the brake lines simultaneously, the fluid will take the path of least resistance and the longer lines will often have insufficient flow to clean out the sludge and corrosion by-products. Also, supplying the new brake fluid to the system while extracting the old brake fluid provides a single flow of fluid through the system, that is, as the old fluid moves out, the new fluid moves in. It has been found that a single flow of fluid through the system oftentimes leaves some sludge and corrosion by-products behind.

Therefore a need exists for a new and improved apparatus for flushing, replacing the fluid and bleeding hydraulic systems which overcomes the shortcomings of the prior art.

SUMMARY OF THE INVENTION

In accordance with the present invention, a new and improved servicing apparatus for flushing, replacing the fluid and bleeding hydraulic systems is disclosed. Hydraulic systems of the type serviceable by the apparatus of the present invention normally include a master cylinder which supplies fluid under pressure to a plurality of slave cylinders each of which has a bleed valve for bleeding air from the system. Most modern brake systems are provided with an Antilock Brake System (ABS) in the form of a computer controlled module which also has at least one bleeder valve. The servicing apparatus has a plurality of bleeder valve lines each of which is for connection to a different one of the